EFFECTS ON THE DESIGN OF PORT FACILITIES REGARDING THE DIFFERENCES OF NATURAL DISASTER CONDITIONS BETWEEN JAPAN AND CAMBODIA

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1. INTRODUCTION

Cambodia has no its own design standards for port facilities and most of port development projects have been technically and financially supporting by foreign countries. So, various design standards have been used to design port facilities in Cambodia which caused it to face many difficulties in port design because its conditions, e.g., natural and other conditions, are different from other countries. Therefore, Cambodia should have suitable design standards to ensure the proper port development.

According to the above situations, the final goal of this research is to harmonize the Japanese technical standards for port design to fit Cambodian conditions. As for the first step of the harmonization, this paper evaluates the differences of major types of natural disasters between Japan and Cambodia which strongly influence the design of port structures, and recommends the suitable design conditions and the suitable structural type of port facilities for Cambodian ports.

2. COMPARISON OF NATURAL DISASTERS

There are several types of natural disasters in Japan and Cambodia. Three major types that strongly influence the design of port facilities in both countries were chosen and discussed. The levels of damages of each disaster were extracted from the website of "The International Disaster Database" for the period of 1900 to 2014 [1].

2.1 Earthquake and Tsunami

Earthquake is one of the worst natural disasters recognized as a major threat to human's lives and properties. Japan is located in the Circum-Pacific Mobile Belt where seismic activities more than M5.0 (max. M9.0) occur constantly and frequently [2]. Since Japan is open to sea, it has also high risk to tsunamis generated by strong earthquakes that occurred under sea bottom along its coast line (Fig. 1). Based on disaster database [1], 161,794 people were killed by 44 earthquakes and 32,576 people were killed by 14 tsunamis.

In contrast, Cambodia has no or very little earthquake seismic activity (Fig. 1) because it is not located near continental plate boundaries like Japan. Based on disaster database [1], Cambodia has no experience in earthquakes. Likewise, Cambodian has no effects from tsunami because its coastal area seems to have been protected by its surrounding islands and neighboring countries.

So, the effects from earthquakes and tsunamis have been considered in the design of port facilities in Japan. But, these effects are exceedingly low in Cambodia.

Keywords: Technical standards, Cambodia, Harmonization, Natural disaster conditions, Port structural type
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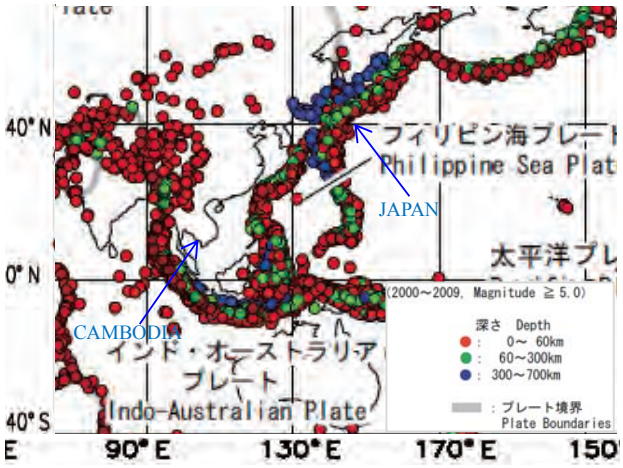

Fig. 1 Distribution of Hypocenters and Plates [2]

2.2 Typhoon (Tropical Storm)

In Japan, typhoon is also one the worst disasters, and causes extensive damages every year. Based on disaster database [1], 34,657 people were killed and 7,863,945 people were affected by 150 typhoons. However, with recently-developed technologies to address disasters, the tendency of disaster damages has declined [2].

Cambodia has rarely affected by strong typhoons. Typhoons, originated in the Pacific Ocean, were always weakened or vanished on the way to pass surrounding countries, e.g., Philippine and Vietnam, before reaching Cambodia (Fig. 2). Based on disaster database [1], there were only three typhoons hit Cambodia in which 44 people were killed and 178,091 people were affected.

Based on Fig. 2, a few typhoons hit Cambodia with wind speed of less than 117 kmh, while many strong typhoons hit Japan with wind speed of up to 249 kmh or more.

Thus, the effects from typhoons have been considered in the design of port facilities in Japan. But, these effects are relatively low in Cambodia.

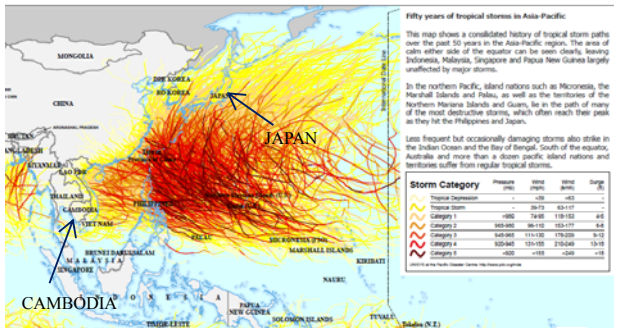

Fig. 2 Tropical Storm in Asia-Pacific 1956-2009 [4]

2.3 Flood

Floods in Japan, which mostly comes with storms, also have severe damages on infrastructures and human's lives.

Based on disaster database [1], 13,096 people were killed by 47 floods. The effects from floods are severe, but major ports in Japan are seaports and the effects are considered only for the ports located at river mouth.
In Cambodia, flood frequently occurs and it is the most severe disaster which causes serious damages to human's lives and infrastructures. Based on disaster database [1], 18 major floods killed 1,421 people. Moreover, river ports [3], connected the major cities on the flooded area [5], play important roles as local and regional transport networks and promote business activities (Fig. 3).
So, the effects from floods are not major subjects in the design of port facilities in Japan. But, these effects are severe for Cambodian ports, especially river ports.

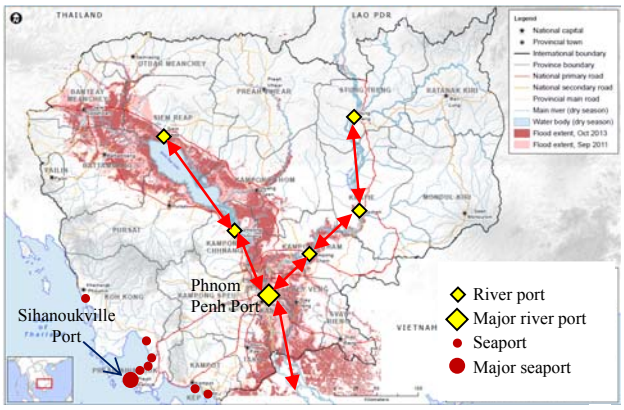

Fig. 3 Port Network & Flood Extent in 2011&2013 [3, 5]

3. EFFECTS OF DIFFERENT DISASTER CONDITIONS ON PORT DESIGN IN CAMBODIA

According to the above comparison of the natural disasters conditions between Japan and Cambodia, the effects on design conditions of port facilities in Cambodia are summarized in Table 1.

Table 1 Design Conditions Suggested for Cambodian Ports

Disaster Type	Comparison of Natural Disasters		Effects in the Design of Port Facilities in Cambodian
	Japan	Cambodia	
Earthquake & Tsunami	Strong earthquake (Magnitude ≥5.0, max. 9.0) kh = 0.05 - 0.27	No earthquake kh < 0.05	Exceedingly low
Typhoon	Frequent and Severe Wind speed: up to 249 kmh or more.	Rare and not severe Wind speed: less than 117 kmh.	Relatively low
Flood	Relatively affect ports located at the river mouth.	Severe and frequent and affect major river ports	Relatively low for seaports, but sevre for river ports.

With regard to the comparison in Table 1, the cost of construction materials was calculated by varying the horizontal seismic coefficient (kh) in order to define the effects of earthquake on construction cost for selecting the suitable structural type for Cambodian seaports. Structure types for the calculation are both block- and caisson-type quay walls with designed depth of -14 m. Firstly, the required cross section was calculated for safety factor of 1.0 or more against sliding and overturning by using Japanese technical standards [6]. And then, the construction material quantity and cost were calculated for each section. Lastly, ratio of construction cost for each case was calculated and plotted in Fig. 4. The trend of the cost reduction ratio shows that the cost for block is much reduced comparing to caisson following the decreasing of kh value. Therefore, the most recommended structure for Cambodian seaports is block-type. In addition, block-type is a simple structure and it requires simple equipment for the construction which are mostly available in Cambodia.

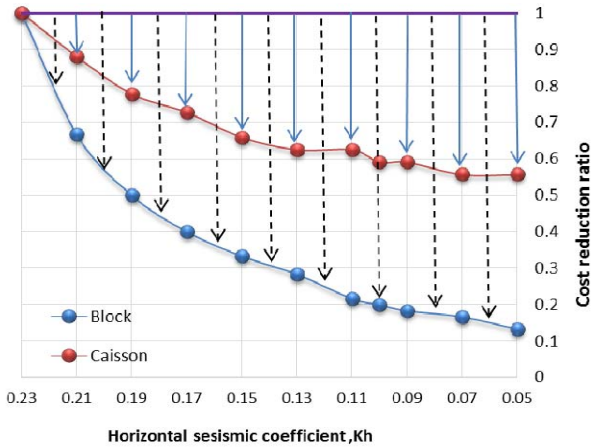

Fig. 4 Reduction Ratio of Construction Material Cost

4. CONCLUSIONS

Based on the comparison of natural disaster conditions between Japan and Cambodia, earthquake, tsunami, and typhoon have low effects in the design of port facilities in Cambodia. And, flood has relatively low effect in the design of facilities of seaports, but it has severe effect on the design of facilities of river ports in Cambodia.
Block-type structure is highly recommended for seaport facilities in Cambodia comparing to the caisson-type because its construction material cost can be reduced following the decreasing of kh value. Also, block-type is a simple structure comparing to the caisson-type and it requires simple construction equipment and technologies which are mostly available in Cambodia.
This approach is important for the harmonization of Japanese technical standards to be in line with Cambodian conditions. For future, this approach will be applied to other conditions, e.g., construction materials and their procurement, manpower, and equipment.

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